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CANADIAN DINOSAURS

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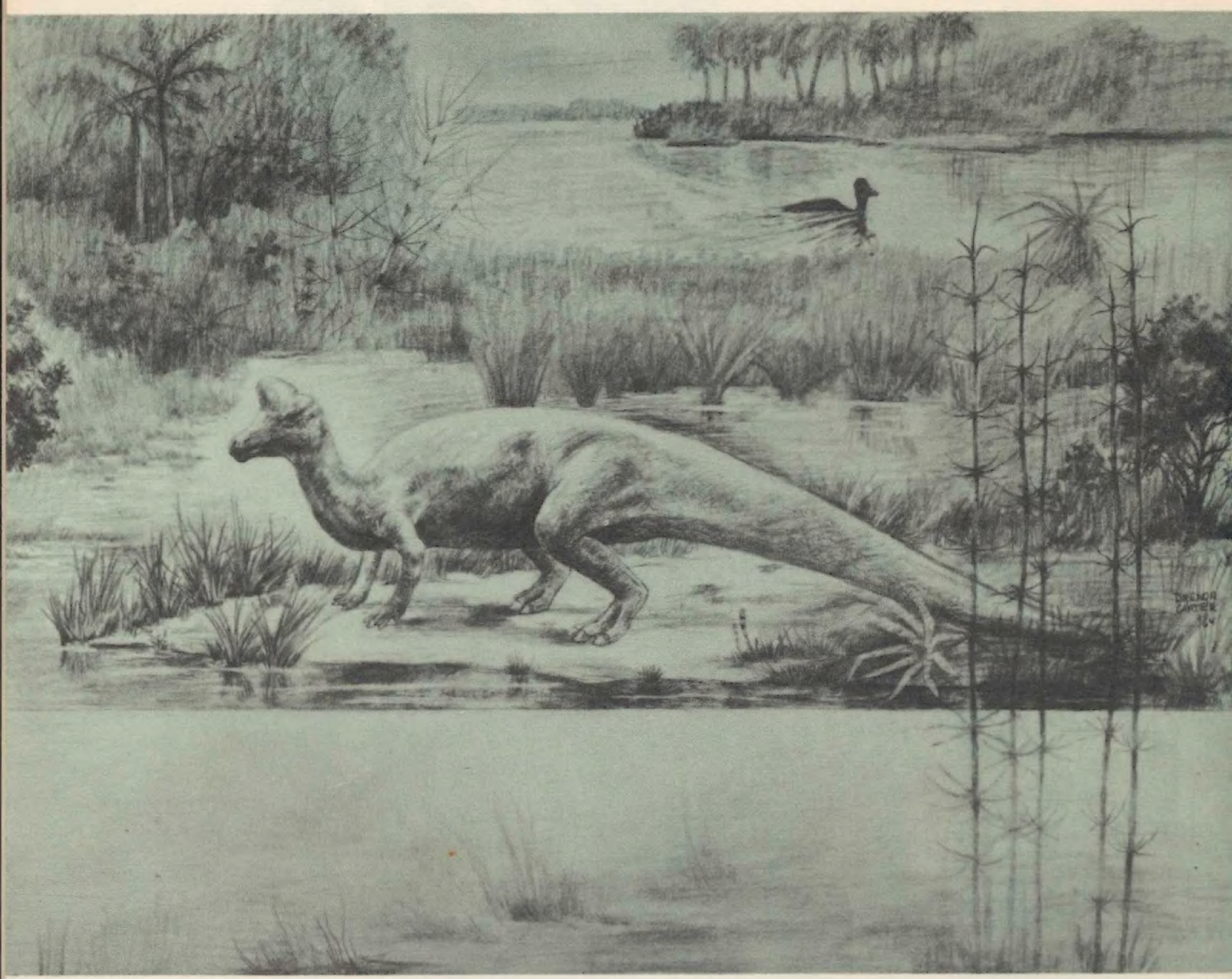


(Neg. J10012)

Figure 1. Duck-billed dinosaur *(Lambeosaurus)* habitat group. By Brenda Carter under supervision of C. M. Sternberg.

CANADIAN DINOSAURS

Introduction

In 1800, Pliny Moody of South Hadley, Massachusetts, ploughed up a piece of flagstone on which was impressed a three-toed track. He regarded it as a bird track and exhibited it as a track of Noah's raven. Later it was realized that it was the track of a small dinosaur.

The first scientific description of a dinosaur was published by Dean Buckland in 1824. The first dinosaur fossil found in Canada was a vertebra of a primitive form, collected by Lieut. Sherard Osborn in 1853 from Bathurst Island and described by R. Lydekker in 1889. In 1874 G. M. Dawson collected dinosaur bones from southern Saskatchewan and Alberta. Later J. B. Tyrrell and T. C. Weston collected incomplete skulls of carnivorous dinosaurs from the Red Deer River district of Alberta. At the turn of the century, L. M. Lambe collected and described several species of dinosaurs, turtles, crocodiles, primitive mammals, and so on, from the badlands of the Red Deer River northeast of Brooks, Alberta. From this small beginning the study of Canadian dinosaurs has gone steadily forward, until now we recognize more than sixty-five distinct species from Alberta alone. Many of these are known from almost complete skeletons, and in some even the impression of the skin is preserved. Although dinosaurs have been found in many parts of the world, Alberta has yielded the greatest number and variety of fine specimens of Upper Cretaceous dinosaurs.

GENERAL DISCUSSION

The Place of Dinosaurs in the Animal Kingdom

Animals with backbones (the vertebrates) are divided into large groups or classes: the fishes, the amphibians, the reptiles, the birds, and the mammals. Fish, birds, and mammals are all easily distinguishable. Perhaps the characteristics of amphibians and reptiles are not so well known. Amphibians have smooth, moist skin, and their toes lack claws. From eggs laid in water, the gill-breathing young hatch and

eventually develop legs and lungs and move onto the land. Examples of amphibians are frogs, toads, and salamanders. Reptiles, on the other hand, have dry scaly skin, and their toes have claws. From eggs, which are laid on land, air-breathing replicas of the parents are hatched. Examples of reptiles are snakes, lizards, crocodiles, and turtles. Those prehistoric creatures which are called dinosaurs were also reptiles.

The name 'dinosaur' is the anglicized form of Dinosauria which was derived from Greek words meaning 'terrible lizard,' although dinosaurs are not true lizards. The name was coined in 1842 by Professor Owen, the English palaeontologist. In today's accepted classification, dinosaurs are regarded as representing two distinct orders of the class Reptilia: the Saurischia and the Ornithischia. The former includes all the carnivores (the Theropoda) and the large brontosaur-like herbivores (the Sauropoda), none of which has yet been found in Canada. The Ornithischia includes all the other herbivores.

One must not imagine that all prehistoric animals lived together; but rather one must realize that during past geological ages a great variety of animals flourished during successive periods of the earth's history. Many of these animals became extinct without leaving descendants; others have persisted to the present without great change. For example, the present-day turtles are not unlike those of ancient times, and crocodiles show only moderate change. Nothing would be known about ancient animals were it not for the fact that many of them left their

Figure 2.
Gorgosaurus **(a carnivore) and** ***Chasmosaurus*** **(a herbivore). Models by L. S. Russell, background by C. E. Johnson.**
(Neg. 95406)

bones, shells, tracks, or impressions in the sand, mud, lime-ooze, or other material that covered them and later became hardened to rock. Through a study of these fossils one is able to view past life on earth and to trace the gradual change through countless generations.

The Dinosaurs

Dinosaurs evolved from a small lizard-like reptile with compact body, relatively long limbs, long tail, and five-toed feet. This creature may not have been very far removed from the ancestor of birds. From this ancestral form developed a great variety of dinosaurs ranging from less than two feet to more than eighty feet in length. Though some of these were the largest land animals that ever existed, their bulk was not so great as that of some of the modern whales, because much of the dinosaur's length was taken up by the very long neck and tail. The limbs were constructed to carry the body free of the ground. However, they were not beneath the body as in mammals, but rather the body was suspended between them. This is especially true of the fore-limbs. All carnivorous (flesh-eating) and some herbivorous (plant-eating) dinosaurs walked on their hind legs, at least in their later development; but many herbivores habitually walked on all fours. Others probably rested on their front feet while feeding, but when in a hurry they assumed the bipedal pose. Some were light-limbed and swift, whereas others were heavy, broad-backed, and clumsy. Some were protected by a bony armour, but in others the skin was thin. Some had very small heads; others had huge

(Neg. J10011)

Figure 3. Horned dinosaurs *(Styracosaurus)* in Cretaceous swamp. By Brenda Carter under supervision of C. M. Sternberg.

heads surmounted by long sharp horns; and still others had powerful jaws filled with long sharp teeth. The brain was a primitive type and very small. In long-necked forms the head was, of necessity, small. In forms with a very large head or powerful jaws, the law of mechanics made it imperative that the neck be short and well muscled.

None of the very large or very primitive dinosaurs has yet been found in Canada. The rocks from which our dinosaurs are collected are deltaic deposits of Upper Cretaceous age, whereas the above-mentioned forms lived during earlier geological periods or in a different habitat. Many other kinds, particularly those found in Europe, have not been found in Canada. However, more than sixty-five distinct species have been described from Alberta. Two localities on the Red Deer River, one about 120 miles southeast of Calgary and the other above Drumheller, have yielded most of these. Fairly complete skeletons or skulls of many species are known, but only parts of the skeletons of other species have been found. Also in collections there are many fragments which are known to represent undescribed forms, but which are

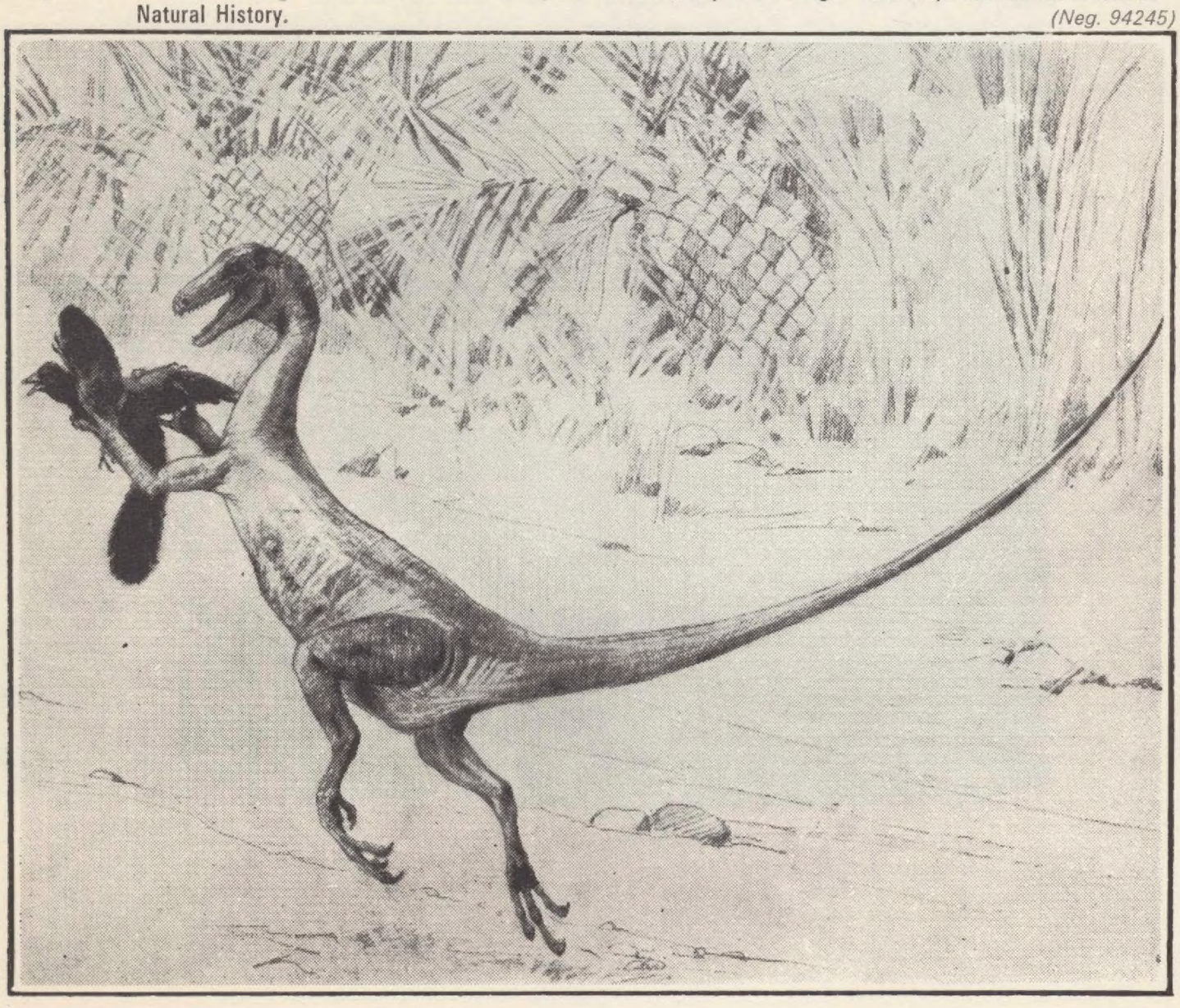
not sufficiently complete to serve as types of new species. Most of the latter are forms that probably inhabited the uplands. If and when dinosaur-bearing upland deposits are located in Canada, probably much more will be learned about the small carnivorous and upland herbivorous forms.

Eight distinct types of dinosaur tracks have been described from the Lower Cretaceous rocks of Peace River Canyon, British Columbia. Some of these tracks were made by carnivorous dinosaurs not greatly different from those found in Alberta, but others must have been made by forms as yet unknown in Canada.

The Age of Reptiles

The Triassic, Jurassic, and Cretaceous periods are commonly referred to as the Age of Reptiles because reptiles were the dominant animals. Several orders of reptiles such as ichthyosaurs (fish lizard), plesiosaurs (near lizard), mosasaurs (reptile from the river Meuse), and marine crocodiles lived in the seas. A great variety of flying reptiles known as

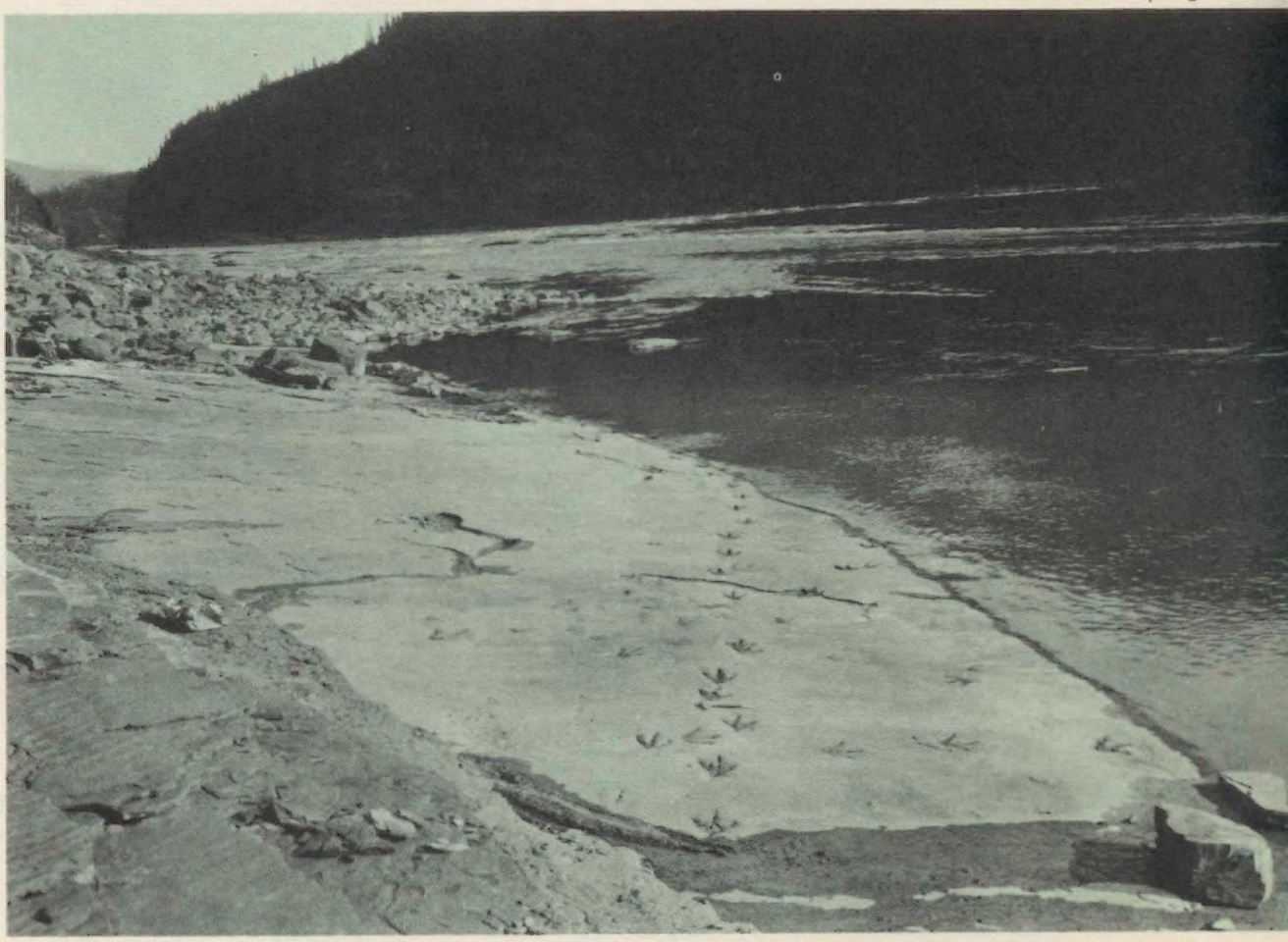
Figure 4. Restoration of a small Jurassic carnivore *(Ornitholestes)*. By C. R. Knight. Courtesy American Museum of Natural History. *(Neg. 94245)*



pterodactyles (wing-finger) glided through the air. Dinosaurs dominated the land from the swamps to the desert uplands. Fourteen distinct orders of reptiles lived during this age whereas only four of these orders are living today. Some of them died out during the early part of the age of reptiles, but five orders became extinct at its close. During the Age of Reptiles many invertebrates, fishes, and amphibians continued to exist, and before the close of the age birds and mammals were well established. Ferns, palms, and rushes were the common plants, and the Norfolk Island pine had evolved. Flowering plants did not make their appearance until toward the close of the age.

Dinosaurs lived during the Age of Reptiles and became extinct at its close, about 60,000,000 years ago. It is difficult for us to comprehend 60,000,000 years, and yet the age itself was more than twice that long and was preceded by the Age of Amphibians, the Age of Fishes, the Age of Invertebrates, and other still earlier periods. Following the Age of Reptiles came the Age of Mammals and the very short Age of Man. These ages are so named because of the dominant animal life

Figure 5. Dinosaur tracks (Lower Cretaceous) in Peace River Canyon, B.C. *(Neg. 73727)*



existing at the time. It is not possible to explain why one period was so favourable for the development of reptiles and another more suitable for the evolution of mammals and birds.

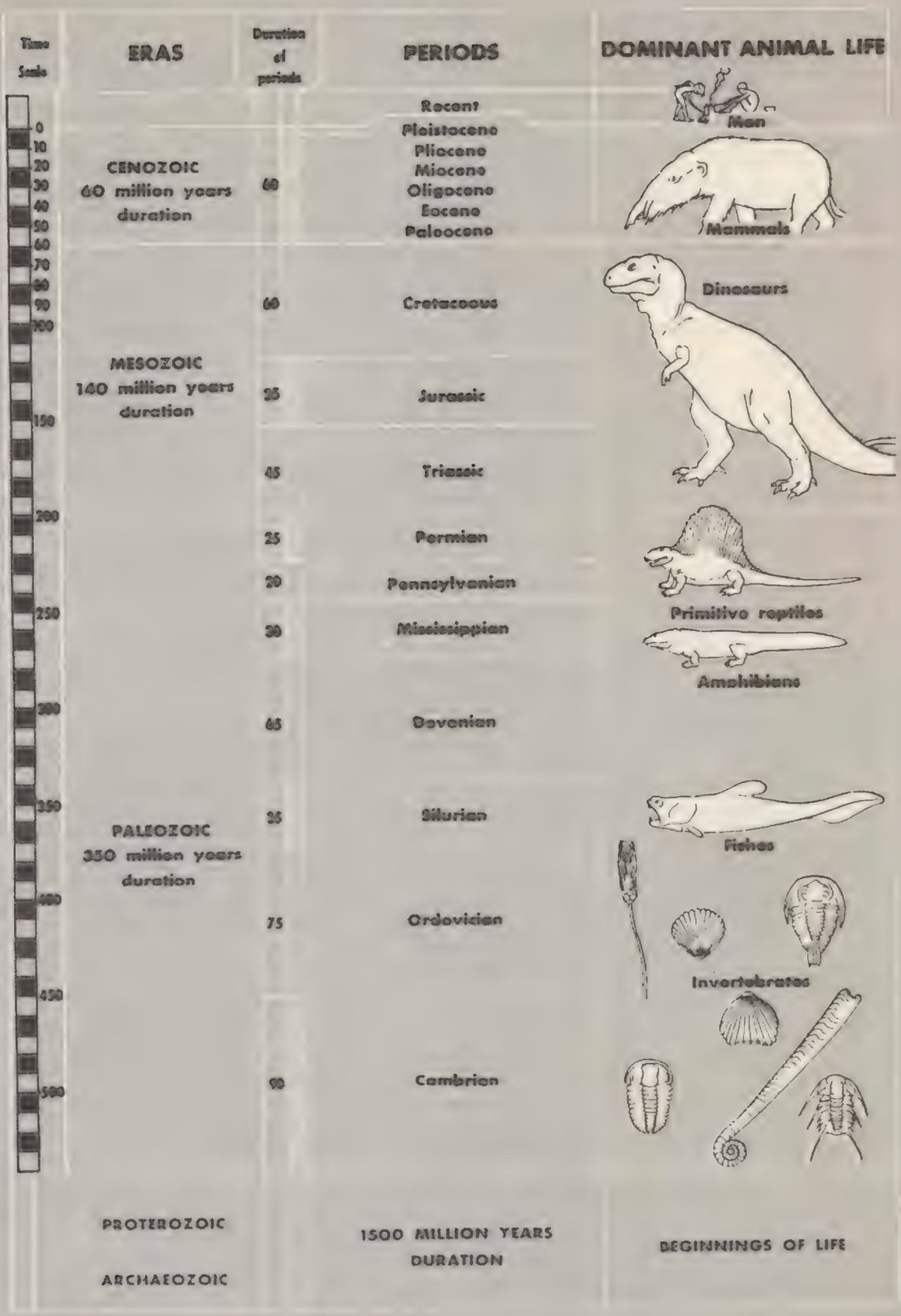
The estimate of the number of years since the close of certain geological periods is not a guess but is the result of painstaking research. For example, by the study of the slow disintegration of radium and uranium into lead, scientists have been able to get a quite accurate estimate of the ages of certain rocks. Other methods of dating ancient rocks are also being used.

Western Canada during the Cretaceous Period

The earth's crust is unstable, and changes are continually taking place. While one area is being depressed, another is being pushed up. During Cretaceous time a great depression extending through the central part of North America was occupied by a shallow sea that extended from the Gulf of Mexico to the Arctic Ocean. The area to the west was mountainous, and sand, silt, and mud from this higher land were carried by streams and rivers and dumped into this inland sea with the result that great deltas were built up. The delta deposits called the Belly River Series, the upper part of which has been named the Oldman formation, extended as much as 100 miles east of the original shore and were up to 1,000 feet in thickness. Following the deposit of these strata the western shore was depressed, and 700 feet of marine deposits (Bearpaw formation) were laid down. Later depression was slower; sediments from higher land to the west were sufficient for the fill to keep pace with the depression, and 1,000 feet of delta deposits (Edmonton formation) were built up. Probably a considerable thickness of upland deposits was laid down above this, but most of it was later eroded away.

Millions of years were required for building up these great delta and marine deposits, and the animal life passed through thousands of generations of slow evolution. Some of the animals were buried in sediments and, if not again exposed, were fossilized by water working through the bones, tearing down tiny cell walls, and leaving in their place mineral deposits. In many cases the replacement is so perfect that every detail is shown just as well as in a freshly cleaned bone, but chemically it is completely changed. Toward the close of the Cretaceous period the Rocky Mountains were being pushed up, and the whole interior of the continent was elevated so that the inland sea drained. There must have been a land bridge connecting North America and Asia, for the same genera of dinosaurs were found on both continents. Since that time, more recent deposits and much of the Cretaceous sediments have been worn away and carried to lower areas such as Hudson

Figure 6. Geological time chart. After Colbert. Courtesy American Museum of Natural History. *(Neg. J9958)*



Bay and the Mackenzie Delta. In still more recent times, rivers cut through the old deltas, and frost, rain, and wind slowly wore away the rock exposing the fossilized remains of ancient animals that had lain buried for millions of years (Fig. 10).

Animals that lived in the swamps and river flood-plains often died in the water, and the bodies of some floated into eddies or backwashes and were buried by sediments without the skeletons being disturbed. This was especially true of the duck-billed dinosaurs. In other cases the carcasses were washed up on the sand-bars or mud-flats where carnivorous dinosaurs and crocodiles fed on the flesh, and although the whole skeleton was present it was pulled apart. Thousands of skeletons were torn apart and scattered. Bones were picked up by flood and washed into the swamps or were washed up onto the beaches in great bonebeds, much as driftwood is piled up at high tide. Some bonebeds consist of limb bones and vertebrae to a thickness of two feet. Occasionally the skeleton of an upland form, caught in the

Figure 7. North America during Cretaceous time. Courtesy American Museum of Natural History. *(Neg. 51694)*

(Neg. 83381)

Figure 8. Naturally articulated skeleton of duck-billed dinosaur ***(Lambeosaurus) in situ,*** east of Manyberries, Alta. *(Neg. 83381)*

flood, would reach the delta without being damaged. Also some of the more durable bones were washed down and buried in the delta. It must be remembered that the fact that the swamp-living forms are most commonly found does not mean that some upland forms were not so numerous, but simply that these upland forms had less chance of being preserved. In the upland deposits of Mongolia, skeletons of young dinosaurs and dinosaur eggs are very common, whereas in Alberta delta deposits, not a single good egg has been found and bones of juveniles are extremely rare. This leads to the belief that eggs were laid on the upland, away from the delta, and that only the more or less mature dinosaurs inhabited the swamps.

The Extinction of Dinosaurs

As indicated, earlier dinosaurs had become extinct by the end of the Cretaceous period. It should be emphasized, however, that they did not disappear overnight. The number of species gradually decreased during the final few million years of the Age of Reptiles until at last there were no more. The riddle of why dinosaurs became extinct the world over has not been solved. Perhaps the answer lies in racial old

Figure 9. Partly disarticulated skeleton of large carnivorous dinosaur *(Gorgosaurus)*, Sand Creek area, Alta. *(Neg. 5214*

age or changes in atmospheric conditions or changes in plant life or the development of more intelligent and active mammals or the uplift of the land and the cutting off of the food supply. Not only did the dinosaurs become extinct at the close of the Cretaceous period, but many marine reptiles and the flying reptiles also did.

COLLECTING DINOSAURS

People often ask "How does one know where to dig for dinosaurs?" The answer, of course, is that one does not dig until one finds a specimen. The skeletons that were buried in the deltas have remained undisturbed throughout the ages, and the mud and sand by which they were covered have become hardened to shale and sandstone. Throughout this long time the skeletons lay buried deeply beneath successive deposits of marine, freshwater, or wind-blown origin; but these deposits have since been eroded away, and once again the ancient deltas on which the dinosaurs lived and died are exposed.

Quite recently, as the geologist counts time, the Red Deer and other rivers have cut gorges into the old deltas, and with the aid of smaller

igure 10. The badlands of the Red Deer River, east of Sand Creek (Oldman formation). The highest point 525 feet above river level. *(Neg. 34759)*

tributary streams and the erosive action of rain, frost, and wind, they have carved out the so-called badlands of Alberta. This is a region of gullies, ridges, buttes, and hillsides from which all soil and vegetation have been eroded thus exposing the ancient strata. As the rock wears away, the tip of a bone may become exposed, and this is what the fossil hunter calls 'a prospect.' If the specimen is not discovered and collected, the bone or bones will weather out and be destroyed. Many prospects lead to only a single bone or a section of the tail or a jaw, but occasionally one leads to a fine skull or perhaps a complete skeleton. No doubt hundreds of skeletons have been destroyed by erosion, and thousands of others are still buried so far from the surface that they will never be seen. When the experienced fossil hunter finds a prospect, he knows whether it is merely an isolated bone or whether it promises a good skeleton. It is not uncommon to find a skeleton of a duck-billed dinosaur without the head and front limbs. The explanation probably is that, as the carcass floated around, the head and fore limbs dropped off, whereas the rest of the skeleton was held together by the stronger ligaments.

(Neg. 25436)

Figure 11. The late L. M. Lambe and the late C. H. Sternberg collecting a specimen from the Oldman formation.

(Neg. 64247)

Figure 12. Naturally articulated skeleton of horned dinosaur ready for wrapping with burlap and plaster.

Horns, claws, and hoofs are composed of keratin and are not preserved as fossils, but the bony core is fossilized, and in one specimen the impression of the keratinous beak was preserved.

When the prospect is located, the specimen is outlined by the use of hand-pick, awl, and small chisel. A certain amount of rock is always left around the bones for protection in removal from the field to the laboratory. If the skin impression is preserved, an extra layer of rock

Figure 13. Skin impression of duck-billed dinosaur.

(Neg. 25994)

must be left. If the skeleton is large, it must be divided into sections, as it is difficult to handle blocks of more than 2,000 pounds. The head and neck may be included in one section; the front limbs, the hind limbs, and the tail in others. If the body part is not too large, it is taken up in one section. When the sections have been outlined and undercut, each is wrapped with strips of burlap dipped in fluid plaster. If necessary, sticks are inserted to give greater strength. When the plaster is set, the section can be turned over and the wrapping completed. Then the sections are packed in boxes and shipped to the museum laboratory. As soon as the wrapping is removed, the slow, careful preparation of the specimen begins.

If the bones of the skeleton are naturally articulated, it may be decided to mount the skeleton as it lay in the original rock. In such a panel mount the separate sections of the skeleton are refitted, and the whole mass is supported so as to keep it together. Such mounts can be studied by future generations, without arguments about the number of vertebrae in the back, the number of joints in the toes, or the proper position of each bone, because they are articulated or held together in the relative positions in which they were when the animal died. With some skeletons it may be desired to show the animals in a walking or standing pose, in which case an open mount is made. In such instances the bones are separated and cleaned and then posed and supported by an iron framework.

(Neg. 29062)

Figure 14. The wrapped skeleton of a dinosaur ready for transporting out of the badlands. This is the specimen shown in Figure 16 (left).

(Neg. 102170)

Figure 15. Preparing a panel mount of primitive horned dinosaurs *(Leptoceratops)*.

Figure 16. An open mount of horned dinosaurs *(Chasmosaurus)*.

(Neg. 67938)

(Neg. 67254)

Figure 17. Skull of *Gorgosaurus*. This skull is nearly four feet long, with the longest tooth about five inches.

CARNIVOROUS DINOSAURS

Five families, in the zoological sense, of carnivorous dinosaurs are known to have lived in what is now Canada. They are classified under the Order Saurischia, suborder Theropoda. Species ranged in size from about six feet long to over forty feet long. These creatures walked on their hind legs using their long tails for balance. In all the carnivores the front limbs were considerably smaller than the hind limbs. In the very large forms, the front limbs were ridiculously small and were probably of little or no use. The very large carnivores, *Gorgosaurus* and *Tyranosaurus,* and the slender bird-mimic forms, *Ornithomimus* and *Struthiomimus,* are well represented in museums. It is believed that they lived in the swamps or deltas. The other three families were relatively small, slender, agile creatures which probably lived on the uplands. These are not so well represented in museums today.

The big carnivores were the culmination of a long line of lowland forms. They attained a length of over forty feet and walked on long powerful hind legs. The weight of the body was carried on three well-

developed toes tipped with large sharp claws. Toes numbers one and five of the hind feet were greatly reduced in size. The front limbs were extremely small, and only two functional toes remained. It is doubtful if these weak appendages served any useful purpose. The head was large, and the powerful jaws, each containing about fifteen lance-like teeth up to six inches in length, were ideally suited for killing and tearing apart even the largest dinosaur. They were by far the largest flesh-eating creatures that ever walked the earth and were the true tyrants of the everglades.

The small upland carnivores were of the same general build as their much larger relatives. However, the skull and skeleton were of considerably lighter construction, and the fore limbs were relatively larger and obviously more useful in catching and holding prey.

The bird-mimic dinosaurs, *Struthiomimus* and *Ornithomimus,* are so-named because in general build they suggest a large ostrich-like bird

(Neg. 103511)

Figure 18. Skeleton of bird-mimic dinosaur *(Struthiomimus),* mounted in Royal Ontario Museum. Courtesy Royal Ontario Museum.

with a long tail, but without feathers of course. The neck was long and slender, and the small lightly built head was without teeth. Although these dinosaurs belong to the same order as did the fierce flesh-eaters, they must have developed new feeding habits. It is not known what they fed on, but perhaps it was on shell-less invertebrates, insects, honey, fruits, or possibly the eggs of other dinosaurs. The front limbs were relatively long and slender, and the three long narrow fingers could have reached into narrow cavities to extract food. The hind limbs were long, and the slender feet with flat claws were adapted for running rather than for grasping, as was the case with the other carnivores.

HERBIVOROUS DINOSAURS

There were at least five distinct families of plant-eating dinosaurs living in Canada during Upper Cretaceous time. These are classified under the order *Ornithischia.* Members of this order had an extra bone in front of the lower jaw or dentary. This bone is known as the predentary and is not found in any other order of reptiles. Three of these families inhabited the deltas, swamps, and river flood-plains, and it is believed that the others were upland forms.

Duck-billed Dinosaurs

The duck-billed dinosaurs are so-called because the expanded horny beak resembles the bill of a duck. They are the best known of any group of dinosaurs. Many splendidly-preserved, naturally-articulated

Figure 19. Skull of a flat-headed duck-billed dinosaur *(Anatosaurus).* *(Neg. 54976)*

skeletons and many complete separate skulls have been collected and studied. More than fifteen species have been described. It is probable that one reason for their prevalence is the fact that they lived in the swamps and bayous where there was an abundance of food. Many of them died in the water, and sediments completely covered their skeletons soon after death (Fig. 8). The presence of a long, high, narrow tail and webbed feet shows that they were good swimmers, and the lack of dermal armour or sharp teeth indicates that escape was their only means of defence (Fig. 1). They probably spent most of their time in the water, and it is doubtful if they ever went far from it except perhaps to lay their eggs. The back is remarkably straight from near the middle of the dorsal region to near the end of the tail. This area is supported by two or three rows of ossified tendons on either side of the neural spine. In front of these ossified tendons the vertebrae arch downward to the base of the neck, and then the neck turns up to articulate with the head. The jaws are at about right angles to the up-turned neck.

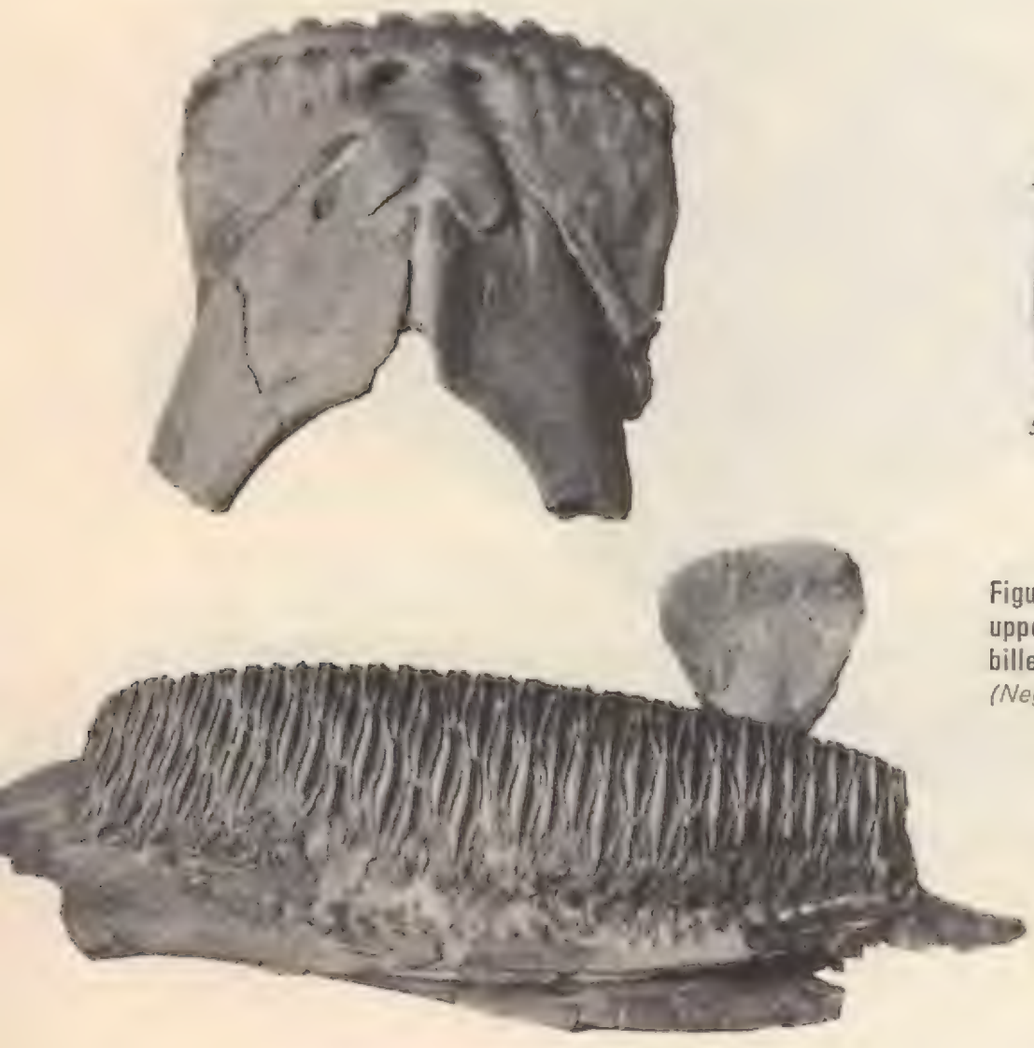


Figure 20. Beak and lower jaw (inner view) of duck-billed dinosaur *(Corythosaurus)*, showing arrangement of teeth in the magazine. *(Neg. 77524)*

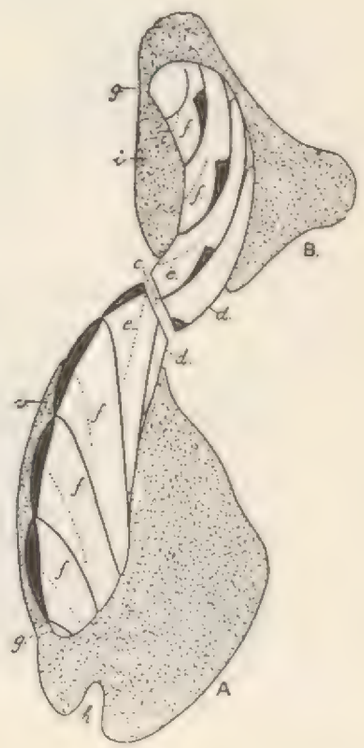


Figure 21. Cross-section through upper and lower jaws of a duck-billed dinosaur. After Lambe. *(Neg. J9325)*

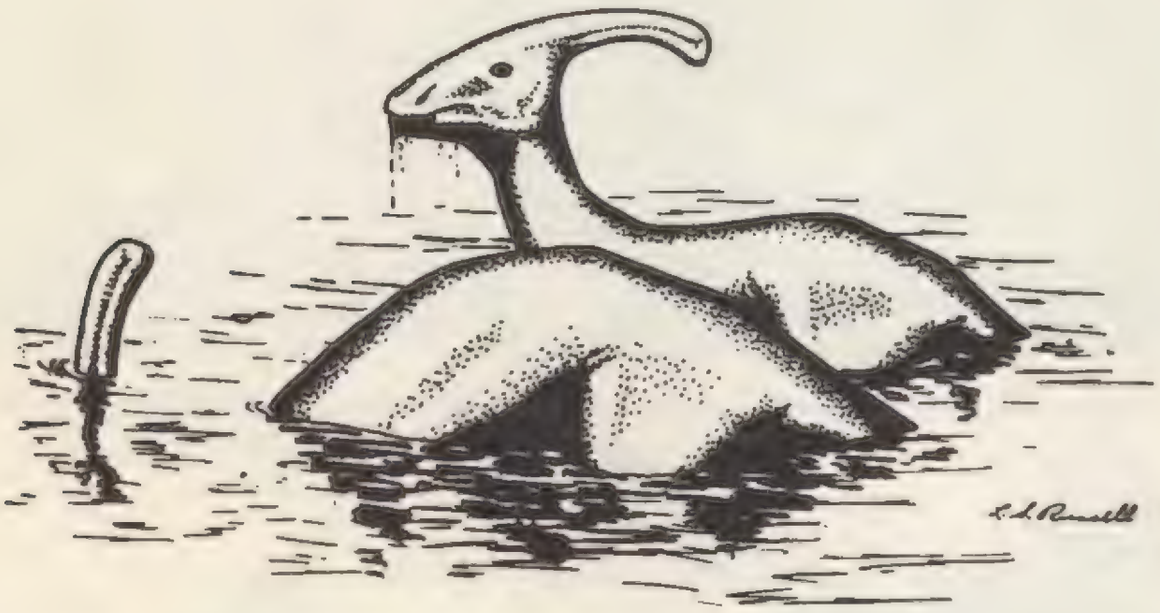
This down-arching of the vertebrae brings the front part of the body below the level of the hips so that the shorter fore limbs could reach the ground if the animal came out on land or was in shallow water. The skin was composed of small scales which did not overlap but fitted like bricks in a pavement. These scales varied in size up to half an inch in diameter, though in some species there were a few larger limpet-like scales along the back and sides (Fig. 13).

In the duck-billed dinosaurs each maxilla (upper jaw bone) and each dentary (lower jaw bone) contained from two hundred to four hundred slender teeth arranged in a magazine of vertical as well as horizontal rows. Only about one-third of the teeth were in use at a time, but as these wore out, new ones grew in to take their place. The lower jaws passed inside the upper jaws, and the teeth, which were worn to a bevelled edge, sheared and crushed the rushes or other swamp plants after they had been nipped off by the duck-like beak (Fig. 20). The number of vertical rows of teeth increased as the animals matured. Apparently there were about eight rows of teeth in each jaw at hatching, whereas in mature individuals there were forty or more rows. Unlike mammals, reptiles do not have specialized teeth with true roots, nor are they confined to two sets of teeth. Throughout life new teeth develop to take the place of those that wear out.

(Neg. 97183)

Figure 22. Model of head of duck-billed dinosaur *(Corythosaurus)* showing looped narial passages.

There were two sub-families of duck-bills, the flat-headed and the hooded. The hooded forms had developed a specialized breathing arrangement which probably was an aid to underwater feeding, although one worker thinks that it was to improve the sense of smell. The premaxillae (those bones that partly surround the external nares) were extended and folded to surround the greatly elongated, looped narial passages. These extended bones grew up and back to form a hood-like development on the top of the head and pushed the nasal bones and the nasal glands back and up over the frontal bones. In one genus *(Parosaurolophus)* the narial passages extended up and back five feet



(Neg. J9959)

Figure 23. Restoration of hooded duck-billed dinosaurs *(Parasaurolophus)*. By L. S. Russell.

from the beak and then looped back for more than three feet to the internal nares. Thus, there was about eight feet of each narial passage completely enclosed in each premaxillary bone.

Horned Dinosaurs

The horned dinosaur group includes forms that ranged from about six feet to twenty-five feet in length, and most forms were swamp dwellers (Fig. 3). They were broad-bodied, low-set quadrupeds with enormous heads. The fore limbs were massive, and, as in all the herbivores, the humerus stood straight out from its articulation with the shoulder blade, making the animals extremely bow-legged (Fig. 16). They had huge parrot-like beaks. The skin was similar to that of the duck-bills, but

the scales were larger. The horned dinosaurs are divided into three families, two of which were hornless. In the most primitive family the animals were quite small; the horns had not evolved and the crest was just beginning to extend backwards (Fig. 24, no. 2). An example is *Leptoceratops*. In the other hornless family, the nasal and pre-fontal bones were greatly thickened; solid bone up to ten inches thick formed the front of the head (Fig. 24, no. 4). The function of this great mass of bone has not been determined. An example is *Pachyrhinosaurus*. Members of the third family are characterized by a horn over the nose and one over each eye. The parietal and squamosal bones were extended backwards to form a great crest or shield, which gave an extra area for attachment of the powerful lower jaw muscles, at the same time providing protection for the front half of the body. The head, including the crest, was equal to about one-third the total length of the animal.

In the evolution of the horns, the first to develop was over the nose; at a later period a horn developed over each eye. Most forms found in the Oldman formation have a relatively large nasal horn and small brow

Figure 24. Horned dinosaur skulls: *Triceratops Leptoceratops Centrosaurus Pachyrhinosaurus.* By Brenda Carter. *(Neg. J10014)*

Figure 25. Armoured dinosaurs *(Palaeoscincus)* in natural habitat. After Matthew. Courtesy American Museum of Natural History. *(Neg. 77048)*

horns. All skulls obtained from succeeding Upper Cretaceous formations have large horns over the eyes and a smaller nasal horn. In *Triceratops* (three-horned face), which was the last of the horned dinosaurs, the brow horns were about three feet long, and there were no openings in the crest as in most earlier forms. Some individuals of *Triceratops* were twenty-five feet long with a head measuring eight feet from tip to tip. When the nose was lowered and the crest thus elevated, the animal was well shielded against attack from even the huge carnivores.

Armoured Dinosaurs

The armoured dinosaurs were low-set, broad-backed, heavy-boned quadrupedal reptiles with short, very massive limbs and short, stubby feet (Fig. 25). All members of this family were encased in dermal armour of bony scutes or plates in the skin. In some species the scutes were high-keeled, thick, and more than a foot long, but in others they were more plate-like with only slightly elevated keels. The large scutes were arranged in rows on the sides and back, the spaces between them

being filled with smaller scutes. The under parts were protected by little, shapeless, bony lumps filling the thick skin. In some forms the short tail terminated in a club-like mass of fused scutes. Except for size these dinosaurs somewhat resembled the little present-day desert lizard known as the 'Horned Toad,' though the dinosaurs were less flat and their heads were relatively smaller. A 15-foot armoured dinosaur would stand about four feet high but would be more than five feet broad at the hips. The teeth were very small and weak, with pointed compressed crowns, and were not suitable for chewing tough plants. One genus had lost the teeth completely and had developed a crushing plate on each jaw. Although the animal was very heavy, its broad body and short powerful limbs enabled it to slither through the swamps much as turtles do. If such a dinosaur were caught on dry land, it could drop flat on the ground, and the bony armour would protect it from the sharp teeth or claws of the carnivores. Most skeletons of this group, which are found in the deltaic deposits, are preserved upside-down, indicating that as the carcasses floated they were turned over by the weight of the heavy plates of bone on the upper part of the body.

Upland Dinosaurs

Two families of herbivorous dinosaurs found in Canada are believed to have inhabited the uplands. One family, the dome-headed dino-

(Neg. J9960)

Figure 26. Skeleton of dome-headed dinosaur *(Stegoceras)*. After Gilmour. Courtesy University of Alberta.

saurs, ranged from about three feet to ten feet in length (Fig. 26). The hind limbs were long, and the four toes were tipped with narrow hoofs that were adapted for running. The head was rather small, but the bones overlying the brain were dome-shaped and very thick. In one specimen, in which the head was about eight inches long, the bone over the brain was three inches thick; in a larger form found in the United States, the dome was nearly nine inches thick. The purpose of this great thickening is not understood.

Two genera of the other family are represented by fairly complete skeletons from the Red Deer River area. No popular name has been applied to this family, but it might be called the small-headed upland dinosaur (Fig. 27). *Thescelosaurus* collected from the Upper Edmonton formation northeast of Rumsey, Alberta, is best known. It was about

Figure 27. *Thescelosaurus* in upland habitat. By Brenda Carter under supervision of C. M. Sternberg. *(Neg. J10013)*

twelve feet long, and the head was less than eight inches in length. The bones overlying the brain were thin, and the body was fairly broad. The moderately long, powerful hind limbs indicate that the reptile was mainly bipedal, although the presence of tiny hoofs on the five-toed front feet suggests that at times the animal may have progressed on all fours. The tail was very long, and in older individuals it was stiffened by ossification of the long tendons. The teeth resemble those of the armoured dinosaurs but are relatively larger. In this family, as well as in the dome-headed forms, the bones in the front of the upper jaws (the premaxillae) possessed teeth.

Of the more than four hundred species of dinosaurs known to science, more than sixty-five have been collected from what is now western Canada. They are from the Upper Cretaceous period and represent the most advanced forms; that is, the most specialized ones and the end of the dinosaur line. With the close of the Cretaceous period, that great group of reptiles known as dinosaurs disappeared without leaving descendants.

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